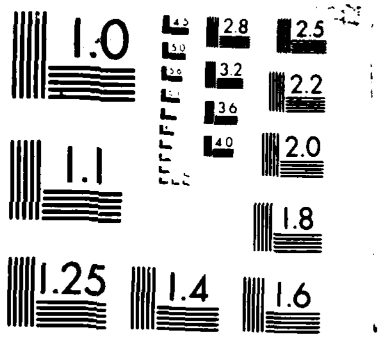
AD-A177 391 EXPERIMENTAL DESIGN OF MULTI-CREWING IN ROK (REPUBLIC OF KOREA) NAVY(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA I S KIM DEC 86 1/1

UNCLASSIFIED F/G 5/9 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

EXPERIMENTAL DESIGN OF MULTI-CREWING IN
R.O.K NAVY

by

In San Kim

December 1986

Thesis Advisor Carson K. Eoyang

Approved for public release; distribution is unlimited.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b OFFICE SYMBOL (If applicable) 54	7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000	7b ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000
8a NAME OF FUNDING/SPONSORING ORGANIZATION 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification)

EXPERIMENTAL DESIGN OF MULTI-CREWING IN R.O.K. NAVY

12 PERSONAL AUTHOR(S)

KIM, IN SAN

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master's Thesis	FROM ______ TO ______	1986 December	52

16 SUPPLEMENTARY NOTATION

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Multi-crewing, Personnel Staffing, Republic of Korea, Navy

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The ROKN is engaged in anti-infiltration operations which call for unlimited time of ships underway. The operation will continue until our political situation improves to the level of the two Germanies. Korean military forces have a primary mission which is obviously military readiness and our vulnerability to North Korean special forces infiltrations places a high priority on anti-infiltration operations. This situation generates high pressure on the ROK military forces. Therefore, the purpose of this study is to develop an optimum organizational structure which will give flexibility in dealing with those two conflicting missions.

Primary research data exists in the experiences of the other Navies which gives basic impetus to this study. Fortunately, the USCG has partially implemented a multi-crew system. The mission and constraints

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a NAME OF RESPONSIBLE INDIVIDUAL Carson K. Eoyang	22b TELEPHONE (Include Area Code) 408-646-2448	22c OFFICE SYMBOL 54Eg

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

Item #19 - CONT'd

of the USCG share similarities with the ROKN and the ROKCG. Those two Korean services try to achieve organizational effectiveness through optimization of given resources. For the additional mission, increasing time of the ships underway is a primary concern which can be accomplished by redesigning the organizational structure. In this thesis, comparisons between various manning models are studied. Secondly, barriers in implementing change in other services are identified, especially the ROKN. Thirdly, appropriate approaches to overcome the common barriers are proposed. Ultimately, a structural design is selected which best matches the organizational environment of the Korean Navy as a fast patrol force.

Approved for public release; distribution is unlimited.

Experimental Design of Multi-Crewing in R.O.K. Navy

by

In San Kim
Lieutenant, Republic of Korea Navy
B.S., R.O.K. Naval Academy, 1980

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1986

Author: In San Kim

Approved by: Carson K. Eoyang, Thesis Advisor

E. V. Haag, Second Reader

W. R. Greer, Jr., Chairman,
Department of Administrative Science

Kneale T. Marshall,
Dean of Information and Policy Science

ABSTRACT

The ROKN is engaged in anti-infiltration operations which call for unlimited time of ships underway. The operation will continue until our political situation improves to the level of the two Germanies. Korean military forces have a primary mission which is obviously military readiness and our vulnerability to North Korean special forces infiltrations places a high priority on anti-infiltration operations. This situation generates high pressure on the ROK military forces. Therefore, the purpose of this study is to develop an optimum organizational structure which will give flexibility in dealing with those two conflicting missions.

Primary research data exists in the experiences of the other Navies which gives basic impetus to this study. Fortunately, the USCG has partially implemented a multi-crew system. The mission and constraints of the USCG share of the USCG share similarities with the ROKN and the ROKCG. Those two Korean services try to achieve organizational effectiveness through optimization of given resources. For the additional mission, increasing time of the ships underway is a primary concern which can be accomplished by redesigning the organizational structure.

In this thesis, comparisons between various manning models are studied. Secondly, barriers in implementing change in other services are identified, especially the ROKN. Thirdly, appropriate approaches to overcome the common barriers are proposed.

Ultimately, a structural design is selected which best matches the organizational environment of the Korean Navy as a fast patrol force.

TABLE OF CONTENTS

LIST OF TABLES

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation for the support, guidance and continuous encouragement in completing this thesis given by my thesis advisor, Professor Carson Eoyang, and my second reader CAPT. E. V. Haag / USN, of the Naval Postgraduate School.

I wish to thank all of the O.D Professors who were always eager to teach and encourage me. Finally, Gary D. Walter and his family who gave me considerable understanding of the American Culture.

I. INTRODUCTION

In the beginning of 1968, the Korean Navy planned to build fast patrol boats of 85 foot length, manned with twenty-four combat crewmen to bring balance between the Navy forces of North and South Korea, as well as for anti-infiltration operations.

In January of 1968, North Korean Special Forces invaded South Korea with the objective of killing the President of South Korea. Even though their attempt failed, the guerrillas infiltrated to Seoul, the capital city of South Korea. Similar incursions continue today. Therefore, in addition to their other missions, all South Korean military and police forces are engaged in anti-infiltration operations. South Korean's enormous vulnerability to North Korean infiltration forces the engagement of all available resources to perform these operations.

A. MISSION OF THE REPUBLIC OF KOREAN NAVY

Basically, the Navy has two conflicting missions: The primary mission is preparedness for international armed conflicts. The second is prevention of North Korean infiltration.

Organizationally, the Navy consists of three fleets:east, west and south. Each fleet operational area has been divided into three subsections for anti-infiltration operations. The commanding officers of the subsections have the primary responsibility for this kind of operation. The primary mission of the east and west fleets is preparedness for conflict, and the south fleet mission is safeguarding transportation routes from attack by the North Korean submarine force.

B. RESOURCE COSTRAINTS, GEOGRAPHIC, MANPOWER, AND OTHER

The primary yardstick for comparison of naval forces is the number and type of ships. This is the primary material resource of any navy. The Republic of Korea Navy (ROKN) vessels can be gouped into three categories: 1) Anti-Submarine Warfare (ASW) vessels, 2) patrol boats, and 3) mine sweeping, amphibious, and other support ships [Ref. 1: pp. 327-338].

Another division could be old style and newly constructed vessels. According to the ROKN's plan for modernization of naval forces, the ROKN will have five frigates, twenty five corvettes, eleven patrol ship multi-missions (PSMM), and a hundred fast

light forces by 1989. Every year, the Navy builds two or three frigates, four corvettes, four light forces, and a small number of other navy vessels. The reason why the Navy has relatively many light forces is, first as a counter strategy against the North Korean Navy and second for increasing the anti-infiltration operation forces. The North Korean Navy has approximately six hundred forty navy vessels which are mostly fast light forces, including twenty two submarines. Therefore, the ROKN should sustain ASW forces and fast light forces.

Human resources can be divided into two groups: One is career, and the other is non-career thirty month term service personnel. According to Korean law, every male adult has an obligation for national defense. Another characteristic is that the Marine Corps is subordinate to the Navy. Although the Marines have their own culture and organization, which is completely different from the Navy, all of their support systems are operated by the Navy. These various ingredients create group conflicts, like those between career and non-career personnel (including officers) concerning work attitudes. The Marines have some dissatisfaction concerning personnel policy and other current support systems. Total manpower of the Navy is generally inadequate to meet their performance requirement. This kind of problem is not only limited to internal Navy organization. Currently, the ROK military system is changing to a geographic divisional command and support system. Therefore, all the different branches are supported through one common organization by geographic area.

Certainly, maintenance facilities are not direct combat forces, but these are a kind of utility or infrastructure. The Navy has one main maintenance complex, which has the ability to perform the highest levels of maintenance. Each fleet has its own maintenance facility which has only a limited ability to deal with boats of less than a hundred feet. Therefore, larger vessels must go to the main shipyard for overhaul. Normally, the larger boats go to each fleet to perform their missions and go back to the main shipyard for one month maintenance after three months operation. This greatly reduces crew time with their families. The crews regard this one month maintenance term as time underway, since they are away from their families. On the other hand, some crew members maintain their families near the main shipyard, since the normal assignment term for officers is one year and for enlisted crew is two years or more. Therefore, those crew members maintain their home base near the shipyard and view other assignments as temporary hardships.

The Navy has various ship systems, and even the same type of vessels have different equipment which makes it difficult for the Navy to keep skilled and experienced work forces. What a crew member learns about the operation of equipment on one ship may not be useful when he is transferred to another ship. Since there are few suitable ports on the east and west coasts of Korea, ships assigned to those two fleets normally spend little time in port, even though they may not really be at sea. For example, the tide on Korea's west coast is one of the highest in the world; Thus Naval vessels cannot tie up even when they are in port.

The fact is that both sides of the Korean Demilitarized Zone (DMZ) have the highest concentration of military forces in the world. A total of over a million military personnel are engaged on both sides of the four mile deep DMZ. The DMZ extends into the Yellow Sea and the Bay of Korea. Therefore, because Korea is still officially at war, being technically in a ceasefire period, a high level of military preparedness is required.

The situation at sea is even worse. The demarcation of the DMZ is more obscure. The North Korean Navy has twenty two submarines which greatly threaten South Korea which doesn't have any submarines. Another critical geographic disadvantage for anti-infiltration operations is that the ROK territorial water is close to other nations' territorial waters, including China and Japan. North Korean enjoys this advantage for their anti-infiltration operations. Their clandestine operations regularly infiltrate through other nation's territorial waters and are safe from ROKN surveillance. They sometimes masquerade as ships of a third nationality. In some cases, ROKN action against suspected North Korean agent boats, which turn out to be vessels of another nationality, has caused international political problems which normally results in punishment for the commanding officer.

Another aspect is that the ROK has more than three thousand islands, which is a great disadvantage to the Navy since there are so many areas with inadequate radar coverage. A small geographic advantage is the high tide which allows North Korean infiltrators only certain times in which they can infiltrate the mainland. Near ROK territorial waters, many fishing boats are active throughout the year. Identification of hostile vessels is a major problem. The ROK has no diplomatic relationships with nearby communist countries, therefore, sea transportation has immeasurable importance to the nation. All foreign contact is by sea or air.

There are two reasons why the total manpower of the Navy is inadequate to meet the requirement: 1) older destroyers require higher staffing levels, and 2) the size of the fleet is increasing as new ships are built each year. The ROK has made a decision to increase the number of naval vessels but has limited total staffing authorizations. Moreover, the high personnel turnover rate and lack of commitment and efficiency on the part of non-career personnel affect productivity in the Navy. The high turnover rate is partly caused by the perception of availability of improved compensation in other areas of the Korean economy.

The Navy recently changed its promotion system which resulted in longer time in grade between promotions. Two years ago, the time in grade requirements for promotion was one year as ensign, two years as lieutenant (junior grade), and three years as lieutenant. That has changed to one year as ensign, three years as lieutenant (junior grade), and five years as lieutenant. The main reason for the increased time in grade requirement is that the Navy's table of organization has been reduced compared with ten years ago. The Navy manpower policy changes quite often. Ten years ago, classes at the Naval Academy graduated one hundred fifty ensigns. Today only one hundred ensigns are graduated. Competition for promotion is more intense because failure to gain one of the limited number of promotions may result in release from service prior to eligibility for retirement benefits. Some otherwise qualified officers see greater opportunity in civilian life. The remaining personnel must strive to be well educated and productive in order to compete for the limited number of promotions. Moreover, the current Navy promotion system is slower than the other services. This is a major factor affecting the Navy members' morale.

The ROK Navy culture follows a pattern similar to the US Navy. The core assumption is that a Navy officer should be a line officer. The line officer is the dominant force in the Navy. Among line officers, Anti-Submarine Warfare (ASW) specialists have been regarded as the dominant group. Other officer specialties are more technically oriented, and require more specialized education. Therefore, the support and technical specialists have been enjoying the advantages of advanced education.

Also, the career track of line officers is difficult to maintain, since once they get assignments out of the Navy's main line, they have a hard time returning to a line position. Therefore, few line officers have an opportunity for long term education. The temporary absence from the mainstream could become permanent. Also,

crewmembers, might more easily permit poor performance. Even if this is not true, there is great reluctance on the part of senior personnel to attribute a high sense of loyalty and responsibility to junior members of the crew. This kind of problem is the basic reason why few Navies implement a multi-crew system. Even where authorized, like in the USCG, it has been implemented only partially.

B. US EXPERIENCE WITH MULTI-CREWS

1. US Navy Case

Traditionally, the US Navy has been manned with a single crew system. In this Navy, I studied two types of modification: one is in ballistic nuclear submarines (SSBN) which have two entire crews per ship; the other one is oceanic research ships that have crew assignments in excess to their authorization. These two kinds of modification derive from their specific missions. The SSBN should be able to stay at sea with high readiness for nuclear war. Regardless of whether it is peace or war time, a certain number of submarines are on sea patrol. Also, the crew's mission is primarily waiting orders for launching their missiles, which keeps the crew in high tension. Adverse working conditions on the submarines, including maintaining silence, might cause psychological problems for the crew. The crew's mental health is extremely important in the submarine service, since the crew deals with enormously destructive weapons. Also, ballistic missiles require regular maintenance every seventy days. These specific conditions increase the advantages of implementation of a multi-crewed manning system. The submarine is manned with two entire crews, identified as gold and blue crews, and change each seventy days while the loaded missiles are discharged for investigation. Once the blue crew delivers the boat to the gold crew during the one week transition period in port, it is free to engage in training or recuperative activities. During the one week overlapping period, both crews check the inventory and sign the transfer of responsibility. This period is the only time that the two crews meet each other. The rest crew participates in education, vacation, training, and assignment to other light duty activities.

Currently, the Chief of Naval Operations announced that the Navy has difficulty maintaining dual-crewing on their submarines, since the Navy doesn't have enough submarine qualified officers. But, the Navy still wants to keep their specific manning system for effective achievement of the mission of the ballistic submarine. Tactical submarines are single crew vessels. Most married crew members prefer the

dual-crew system over the single crew submarine assignment since the dual crew system gives them more time with their families and they can plan their time schedule. Unmarried crew members sometimes look for single crew assignments because the young crew members consider the attack submarine mission to be more exciting, i.e., searching for the enemy instead of just awaiting action [Ref. 3]. But, some higher ranking crew members prefer a single crew system, even on ballistic submarines, since they believe that the single crew system is better for maintaining crew morale and keeping team spirit among their crew. Lower ranking crew prefer to be assigned on dual crewed ships. Basically, this kind of manning system can hardly avoid maintenance problems which should be viewed as group conflicts between the two crews. The ballistic submarine has a higher maintenance priority than any other Navy vessel. For example, the ballistic submarine's least maintenance priority is the same as the attack submarine's highest priority. Therefore, malfunctioning equipment could be easily replaced, even though the gold crew might blame the blue crew. One of the crew interviewed said that the SSBN really has three crews. The reason is that each crew blames some other crew, resulting in blame for an irresponsible crew, other than the blue or gold crews.

However, in this case, highest possible priorities for resupply and re-equipping indicates that sufficient resources could reduce conflicts. This condition is as Jeffrey Pfeffer states in his book, Power in Organization. Normally, ballistic submarines cost three what it costs to operate attack submarines. Since the maintenance priorities and systems are different from each other it is impossible to compare ballistic submarines with attack submarines in terms of cost benefit analysis. Over all, the ballistic submarine case doesn't show much conflict between crews [Ref. 4].

But, the evaluation system has to be improved, so that each crew is evaluated separately, even though they are based on the same platform. If the gold crew performs well, then the blue crew can enjoy the gold crew's good job. But, if the gold crew erred the blue crew might have a hard time to correct the gold crew's poor performance. As far as I know, the submarine officers and the crew are highly qualified and carefully selected members who are proud of their skills. Their job confidence contributes to their high performance, since it does not allow poor standard of performance.

Therefore, the problems which are associated with crew members' poor performance might be a minor problem. Although each crew separately maintains an

acceptable level of performance, the noncommonality between the two crews may still cause inefficiency. Can one ship with two crews be considered a single organization? It is necessary to take actions which will bind these two crews into one unit. Personally, I believe this problem should be carefully considered and team building theory might be an appropriate means. Team building activities could be done during the crew overlap period. Another dimension of multi-crew system is that the U.S. Navy doesn't utilize the rest crew during the seventy days in port time during which the crew is mostly assigned to education, training, and light duty. Even well prepared training and educational courses will not be of significant importance to the crew if they are repeated over and over again. Also, light duty is less meaningful and, it appears to me, doesn't have productivity. Although the rest crew might not be necessary to the Navy, keeping the highly qualified crew in an idle state isn't conducive to highest morale.

The other multi-crew manning system is used on oceanic research ships which keep more crew than required, usually one or more extra man per each functional area, and excess crews have rest in rotation. Crew members are usually allowed a two week leave during each six month cruise. It is normal for oceanic research ships to go sea for a six month term. This kind of rest and recuperation leave is required for this type of ship.

2. USCG

The US Coast Guard case has similarities in mission requirement and environment with the Korean Navy. The mission requirement is that both services require a high level of ships presence at sea with limited resources. Both services heavily rely on small patrol boats for anti-smuggling and anti-infiltration operations. Their operational concepts are similar, too. The two services boats are usually engaged in actions four hours per day and those boats are deployed at each base as a squadron. Additionally, the Coast Guard has partially implemented the multi-crew manning system. Unlike the U.S Navy multicrewing experience, where boats of one type are multicrewed and boats of another are not, the U.S. Coast Guard has single crewed and multicrewed vessels of the same type. This difference is significant and offers opportunities for comparisons between single crew and multi-crew manning systems which cannot be made in the U.S. Navy system.

Basically, the Coast Guard has implemented several kinds of multicrew manning systems: 1) two crews per ship, 2) one crew per ship with the crew operating

as two crews, 3) three crews for two cutters, and 4) one maintenance team for several larger cutters. The first system has two separate crews assigned per cutter and the two crews rotate. One crew is at sea while the other crew is in port for rest or training. This kind of manning system is similar to the US Navy ballistic submarine multicrewing system.

In the second system, crew members are organized as one crew, but each functional area has two specialists who can perform the job independently. There is a common commanding officer and executive officer. For one period, the commanding officer takes the cutter on assignment with half of the crew. During the next period, the commanding officer and the returning crew are replaced by the executive officer and the other half of the crew. But, there appears strong reluctance to implementing this manning system since the seamen have strong loyalties. Therefore, the commanding officers have a hard time letting the executive officers be in charge of cutters. (The executive officer may be a senior enlisted man.) [Ref. 5].

In the third system, the three crews rotate their mission with two crews engaged in action while the third crew is in port. After a certain time they rotate their crews, with the "in port" crews swapping places with one of the two others.

In the last manning system, the maintenance team takes the cutter from the crew for regularly scheduled maintenance, and the crew takes their planned action, such as training or rest.

Eccles (1986) studys crew perceptions about multi-crew manning systems in the U.S. Coast Guard. The summary of his study states that the strength of the manning system is additional free time to crew members compared to the single crewed ship. And the additional assigned manpower improves the ship's maintenance level and increases productivity. Additionally, there is reduced fatigue that derives from relief available by way of crew rotation. The negative perceptions or problems associated with the manning system are mainly inconsistency and lack of uniformity. Poor communication and incomplete briefings during actual crew rotation results in inefficient or redundant work distribution and unclear authority and responsibility. Also, a lack of team spirit is demonstrated when distinct separations between crews exist, resulting in level of training conflicts, and unhealthy competition between crew members.

In some other Korean military services, particularly the Marine Corps and the Army, a similar concept has been implemented. When they change their troops in

DMZ, they set three steps for troop change. The first step is that new troops conduct exercises near their area of responsibility, and secondly, the new troops exercise together with the existing troops. During the combined exercise, the new troops will build familiarity about their area of responsibility, like geographic and hostility information. The new troop could develop familiarity during conduct of the combined exercise. This exercise takes about one week. The final stage is withdrawal of the former troop. This is the standard procedure of troop exchange in strategically important areas of Korea. In another specific case, the Marines adopt more delegated procedure on the company level. The procedure is that the new company sends half of their troops to their assigned area receives half of the other company's members. Finally, they change the rest of the members. The procedure takes around one month. Certainly, the responsibilities are not technically the same as with Navy vessels, but the idea of the replacement procedure is similar. Although the Navy has a more clearly defined work area within the ship or boat, the geographic condition and other facilities can be viewed as a system with which the new troop should become familiar.

During the study of the US Navy, I found many disciplinary experiences which could apply to the Korean Navy. Especially, the transition phase from conventional submarines to nuclear powered submarines revealed interesting contrasts. One issue is that the diesel powered submarine officers felt that they were second class citizens compared to officers on the innovative new submarines. The Korean Navy is transiting from old fashioned vessels to newly constructed ships. Currently, the Navy still uses both modern and older vessels. Therefore, some officers have experience with new equipment, while others haven't. This is the similar situation to the US submarine case. We should be aware of this kind of experience in other Navies.

3. **Potential Benefits to ROKN**

The biggest concern is that the Navy can maximize its resources utilization through modification of the manning system, A cost benefit comparison study result reveals a 44% increase of the ship's steaming hour with a 40% reduction of cost per steaming hour. Also, the maintenance costs increased but the additional cost was only 11% [Ref. 5: p. 40]. If we consider the cost of the newly built ships, then the additional maintenance cost is not a big problem.

In addition, the Navy could improve crew morale which could be the most significant benefit in dealing with the specific character of anti-infiltration operations. The analysis of cost-benefits is discussed later.

The Navy's morale problem derives from two reasons: one is that demands on crew time are excessive. As a consequence, the crew finds it is hard to maintain their private lives. Secondly, there are decreased opportunities for promotion coupled with an "up or out" policy. Therefore, Navy members feel that their futures are unstable. The prudent officer will contemplate his options.

Multi-crewing can allow the Navy crew to have more opportunities for training, advanced education, and more time with their families. Many modifications could be applied to the Navy. For the patrol boats, dual crewing might be proper, and for the bigger ship, keeping the maintenance team might be appropriate. Current diversification of the fleet forces and deployment at each area greatly reduces the crew's in port time, since the Navy has only one main maintenance complex which can deal with larger naval ships.

The results of the additional training and education made possible by multicrewing will not be evident in a short period, but the effect will make a great difference in the long run. The current study reveals that the additional training and education is the most important motivational factor for organization members. The Korean Navy line officers are surface specialty officers who are the actual work force at sea and they tend to keep on the career track in the Navy. The current situation doesn't allow them to have any advanced education. The current view is that academic education isn't as *valuable as military* training for the Navy officer. The Navy suggests many advanced educational courses, but the personnel policy problem associated with the educational policy is that once a line officer engages in advanced academic education he has difficulty maintaining his career track. Therefore, the line officer finds it difficult to take that kind of suggested educational course which will benefit the Navy in the future.

If the Navy adopts an alternative manning system which could give the line officers more opportunities for education, then more qualified personnel will remain as line officers. Normally, the top Naval Academy graduate officers change their specialties to take advanced educational courses. Those specialties, such as communications, instructor, supply, facility, etc., could take their required education in some civilian universities. Also, education is of great concern to the officers since that kind of advanced education will help the officer personally. A military job can not be permanent. The most successful person can keep his career only about twenty five years. What is the next step after the end of the military career? Obviously, the

successful person can have another civilian or official job after retirement. How about most other career officers, especially line officers, who haven't have any opportunity for other advanced education? Although this cannot be the driving force behind modification of the manning system, it certainly can be a side benefit which will be of motivational value. The more secure an individual is about his future, both within the service and after his retirement, the better will be his current performance.

III. COST BENEFIT ANALYSIS OF MULTI-CREWING

The first step in a rational approach to develop a better alternative for the Korean Navy organization through maximizing the utility of available human and material resources is the identification of strengths and weaknesses of a multi-crew system with cost benefit concepts. The study of the USCG is a comparison of operating and maintenance cost between single crewed and dual crewed systems of the United States Coast Guard (USCG), which have already been tried and analyzed by other navies [Ref. 5].

A. SOURCE OF DATA

A comparative analysis was conducted between seventeen single-crewed and multi-crewed ships, in three areas over a two year period. Basis for comparison was resource hours and operating cost per hour, maintenance hours, and annual inspection results.

Thirteen vessels, six conventional manned ships and seven dual crewed ships, were stationed along the California coast between Eureka to the north and San Diego to the south. They all had the same mission demand with similar operational environments.

Also, two 95′ vessels, home ported in Miami, Florida, were manned by three rotating crews, and two other singlecrewed vessels were home ported in Key West, Florida. Those different manned vessels were identified as units with geographic areas of responsibility and mission requirements similar enough to make a comparison reasonable, and the survey result showed a difference from 85′ vessels.

The number of resource hours for each unit was acquired from the annual summary of Operational Statistics provided by the office of Operations, Plans and Programs Staff (Table 1).

The operating costs were obtained from the annual summary of Operating Cost of Coast Guard Cutters provided by the Office of the Comptroller, Accounting Division (O-FAC-6), Coast Guard Headquarters, Washington, D.C. The cost included military pay and allowances, operating maintenance cost and fuel, electronic program updates, vessel program updates, and miscellaneous costs.

Table 2 is the annual ships' inspection results, which military persons regard as representative of vessel readiness.

Following are the survey results.

TABLE 1
WPB RESOURCE HOURS AND OPERATING COSTS-FYS 84 85

82' SINGLE CREW			
CUTTER NAME	RESOURCE HOURS	OPERATING COSTS	MAINTENANCE HOURS
POINT BARROW	840/1,062	$297,558/272,658	2,339/2,705
POINT CHICO	952/1,038	$249,576/362,924	2,147/2,679
POINT HEYER	1,092/1,094	$272,095/387,697	2,261/3,433
POINT HOBART	1,234/1,409	$349,050/271,713	2,841/2,439
POINT LEDGE	770/805	$439,451/495,423	2,253/3,652
POINT WINSLOW	845/1,126	$320,136/256,348	2,138/2,838
AVERAGE ANNUAL	1,017	$331,219	2,643.8
82' DUAL CREW			
POINT BRIDGE	2,579/2,470	$317,356/379,489	2,081/2,901
POINT BROWER	2,459/2,068	$265,722/229,292	2,145/2,021
POINT CAMDUE	2,330/2,063	$275,083/237,127	2,203/2,643
POINT DIVIDE	2,296/1,740	$320,364/329,018	3,022/2,617
POINT EVANS	2,268/1,829	$343,300/362,600	3,161/2,717
POINT SUDITH	2,024/2,279	$301,988/362,859	2,208/2,564
POINT STUART	2,457/1,690	$205,588/310,152	2,256/3,912
AVERAGE ANNUAL	2,182.3	$302,888	2,603.8
95' SINGLE CREW			
CAPE FOX	2,893/1,747	$337,296/474,895	
CAPE YORK	2,767/2,080	$409,243/360,906	
AVERAGE ANNUAL	2,372	$395,585	
95'MULTI CREW			
CAPE CURRENT	2,330/2,766	$553,884/388,979	
CAPE GULL	3,124/906	$400,341/452,088	
AVERAGE ANNUAL	2,282	$448,823	

TABLE 2

FY 85 ANNUAL INSPECTION RESULTS FOR WPBS

CUTTER NAME	OVERALL INSPEC	MATERIAL INSPEC	NAVAL ENGINEERING	ELECTRONIC ENGINEERING	PERSONNEL INSPEC
82' SINGLE CREW					
POINT BARROW	E	G	G	E	G
POINT CHICO	O	O	O	G	O
POINT HEYER	E	E	G	E	E
POINT HOBART	E	E	G	E	E
POINT LEDGE	U	E	G	G	G
POINT WINSLOW	E	O	E	E	O
82' DUAL CREW					
POINT BRIDGE	E	E	O	E	O
POINT BROWER	O	E	O	O	O
POINT CAMDUE	E	E	E	O	E
POINT DIVIDE	O	O	O	O	O
POINT EVANS	E	O	O	E	O
POINT SUDITH	O	O	O	O	O
POINT STUART	O	E	O	O	O
95' SINGLE CREW					
CAPE FOX	O	O	O	NR	O
CAPE YORK	E	O	E	NR	O
95'MULTI CREW					
CAPE CURRENT	E	G	E	NR	O
CAPE GULL	E	G/E	G/E	NR	O

O: outstanding E: excellent G:good
U: unsatisfactory NR: not reported

B. DATA ANALYSIS

By definition, a cost benefit analysis (CBA) is "an estimation and evaluation of net benefits associated with alternatives for achieving defined public goals." Cost-benefit is a generic term embracing a wide range of evaluative procedures which lead to a statement assessing cost and benefits relevant to project alternatives. Also, the variety of problems addressed and the ingenuity which must be exercised in estimating costs and benefits makes it particularly difficulty to design an all purpose CBA procedure [Ref. 6: p. 48].

Therefore, I intend to analyze the term Multi-Crew by the following criteria.

First, define the analysis areas which are under constraint of given resources--human resource (number of crew) vs. material resources (ships). The human resource dimension is not the number of crew members but the manpower required to achieve the stated organizational goals. In this thesis, the goal of the USCG is to prevent smuggling, and perform search and rescue. The material dimension is the number of Coast Guard cutters necessary to achieve the goals, which should not be confused with improvement of the ship's ability to perform operations. Basically, the two factors are complementing each other in performing the specific operations. To increase the cutters' presenting time at sea, the two factors required can be traded off under consideration of the multi-crew concept. That is, a certain amount of time of cutters' presence can be accomplished by a combination of different level of each resource. Also, the required level of each resource can be determined by comparison of each factor's impact on productivity. Therefore, there are two possible areas to be studied; one is how much manpower is required to increase each cutter's effective operation. The other one is how many crews are appropriate for a given number of cutters. The first one requires a determination of the proper level of manpower per cutter. To analyze the impact each of additional crewmember requires sensitivity analysis of individual crew's performance, and relation between man and cutter's design. I intend to analyze optimum crew staffing for one cutter, in order to establish that a multi-crew system is more effective than single crew system in the specific operation.

Second, set a standard of comparison between multi-crewed ship and single crewed ship's performance evaluations, operating cost, and maintenance cost. The theoretical background to set a standard of evaluation will follow Sugden and Williams's "Quantifying Cost and Benefit." It is not enough in cost-benefit analysis to describe effects of a project as harsh, or slight, or moderate, or whatever. Quantification is the aggregation of effects and the analysis of trade offs. Also, Sugden and Williams emphasizes the importance of identification of all the relevant costs and benefits, and they demonstrate a quantification method which can facilitate the analysis.

Table 1 reflects that the average number of hours underway annually during fiscal years 1984 and 1985 for the six single-crewed 82' WPBs studies was 1,017 at an average annual cost of $331,219. The resulting cost per hour underway for this type

unit was $325.68. The seven dual-crewed platforms proved significantly more productive and efficient, with an average number of hours underway annually during FYs 84 and 85 of 2,182.3 at an average annual cost of $302,888. The resulting cost per hour underway for this type unit was $138.79. The fact that the average operating costs for a patrol boat with a smaller crew and less than half as many average annual resource hours was higher than dual-crewing configuration necessitated a closer examination of the breakdown of costs.

The data reveals that the average annual maintenance costs for the single-crewed boats were 44% higher than for the dual-crewed boats, and vessel programmed updates are scheduled independent of annual cutter operations, not a function of crewing configuration. However, even after eliminating the approximately $25,000 additional cost per single-crewed hull for this expense, the dual-crewed vessels cost slightly less to operate per year and are more than twice as productive. Also, the six single-crewed units required an average of 2,643.8 hours of maintenance per unit in order to accomplish their average of 1,017 hours underway annually, or 2.6 hours of maintenance for each hour underway. The seven dual-crewed units required an average of 2,603.3 hours of maintenance to accomplish their 2,182.3 hours underway, or 1.19 hours of maintenance for each hour underway. This increased opportunity for maintenance performed by the single-crewed units may provide constructive employment for the crew while in port, but does not appear to be necessary to increase the utility of the platform.

An additional concern expressed during the study was that vessel maintenance and appearance would suffer for lack of the full loyalty experienced with single-crew unit ownership. However, Table 2 failed to show any significant differences concerning maintaining the unit between the two crewing configurations, but the result reveals dual-crewed units achieved slightly higher average rating in every category.

In the case of 95' vessels, the study failed to show the significant improvement of productivity by implementation of multi-crew system. However, the two 95' vessels adapted a different way of multi-crew system, and that will require more specific organizational study. Since only two 95' vessels were involved, it is possible that these figures are not generalizable.

C. DISCUSSION OF RESULTS

This simple analysis with limited data reveals that a multicrew system is more productive or efficient than a single-crew system. But, the analysis only evaluated the relationship between ship and crew on the divisional level, which may or may not mislead decision makers. Therefore, I intend to evaluate more carefully by expressing other possible impacts or consideration points which should require additional study.

Traditionally, cost-effectiveness analysis studies, which are the specific term of cost-benefits analysis, are used in two different types of situation: 1) to maximize output for a given amount of resources, or 2) to minimize costs for a given set of objectives. Done properly, the ultimate outcome of the analysis should be the same. So often, it is not possible to figure out the benefits to be obtained from a particular social program. When this situation occurs, agencies can use a truncated version of Benefit-Cost analysis.

In performing a cost-benefit analysis, an appropriate decision criterion is required. Many criteria have been suggested as appropriate for evaluating alternative investment projects according to the situation. Following are the common criteria used in cost-benefit analysis [Ref. 6: p. 17]:

- NET PRESENT VALUE: This method has an advantage which is reduction of costs and benefits to a single number in which costs or dollar benefits are discounted. The major disadvantage of this is the determination of the proper discount rate.
- BENEFIT-COST RATIO: This method, which is also defined in terms of discounted value, gives the benefits per dollar of cost. Thus, the smaller of two projects may have a higher B C, yet yield a smaller total net benefit.
- EQUITY: This criterion addresses the impact of benefits and cost of a project on the individual members of society. In the final analysis, the decision maker must subjectively weigh the NPV of a project against any adverse equity consequences. This will reflect the decision maker's own ethical standards, and may also include political realities.

The identification of cost and benefit of a specific project requires following assessment schemes [Ref. 8: pp. 17,24].

Internal vs external effects: In a simple case, internal effects are that the benefits returned by an investment would be the revenues produced. In other words, the internal benefits are those increases in value produced by the project itself.

External effects are those effects involuntarily received by others for which they pay nothing. These effects are neither deliberately produced nor deliberately consumed, and are also often called externalties, which can be classified as technological and pecuniary.

Incommensurable vs Commensurable: Commensurables are those of a material or economic nature, while incommensurables are those involving values beyond economic. Also, incommensurables should be distinguished from intangibles as differences that can not be readily translated into the common denominator or denominators that are being used, and nonmeasurable in even their own terms.

Therefore, incommensurables refer to all extra-market effects and use intangibles to describe quantitative terms that are noneconomic in nature.

The benefits of a multi-crew system can be interpreted as commensurable and incommensurable: Increasing ship's presenting time at sea vs crew motivation.

Since the analysis was done under the divisional level, what are the additionally required research areas at higher than divisional level. Implementation of the multi-crew requires more crews than an additional number of vessels. In this, USCG cutters are not as high value units as other Navy vessels, like nuclear submarines or aircraft carriers. But, the term "economic war potential, in a nuclear period" should be additionally considered for implementation in the Navy. Therefore, even the Navy which has only conventional armed force should consider an appropriate requirement of vessels.

The trade off between number of vessels and crews should consider each additional cost, in terms of opportunity cost and relevant cost. The additional crews require costs for recruitment and retention. Also, the additional vessels require cost for construction and maintenance, furthermore other facilities which include additional pier and increased maintenance facilities.

As stated previously, there are incommensurable factors associated with implementation of multi-crew system. The increased productivity through implementation of multi-crew system should be evaluated not only in hours of ship's presence at sea, but also quality of crew performance. The data, Table 2, shows multi-crewed units are better than single-crewed units. Also, defining the spillovers of the two different systems are required. From implementation of multi-crew, the Navy can offer more jobs, but reduce the revenue of the ship building company.

D. CONCLUSION AND IMPLICATIONS

The performance of military service is hard to analyze in terms of cost-effectiveness because it is hard to define the measure of effectiveness. Any organization has certain kinds of constraints to achieve its goals, but we are required to

achieve maximum effectiveness within given resources or minimize cost in given effectiveness. In this study, I defined the resources as two categories--human and ships. The Korean maritime services have traditionally manned their ships with a single crew per vessel and a ship's operating schedules have been decided by the ship's maintenance condition. The urgent action requirement doesn't allow consideration of human factors. Overall combat readiness is determined by the maintenance condition of the ship and the performance ability of the crew. Every year the ROKN builds ships but still does not have enough to perform the added mission that calls for increased presence of ROKN and ROKCG. It may be that now is the time to suggest better working conditions for the crew. To increase the number of crew requires more cost but that is still cheaper than building additional military ships.

The case of the USCG is strong evidence to support the benefit of the multi-crew system. On the other hand, the reasons, it appears to me, why they stopped the beneficial system are the justification why ROKN should consider implementing the change. The barriers mostly came from psychological conflicts that could be categorized in two forms--one is group conflict between crews; the other one is resistance to change among the senior sailors. These barriers could be avoided by improving organizational development techniques.

IV. EXPERIMENTAL DESIGN FOR MULTI-CREWING IN ROK NAVY

The purpose of this experiment is to identify and analyze the benefit and relevant cost of a multi-crew system for the Republic of Korea Navy. Also, the well planned implementation will give a better idea for the Navy. In a previous chapter, I have introduced US Navy and Coast Guard cases and identified the benefits and cost of the manning system, but the other navies' experiences might not be appropriate to the Korean Navy, since the Korean Navy has developed their specific organization under the different circumstance in their specific environment. More precisely, the other navies' experience could give an adequate guide when changes could be made in small increments. But the different services' experience will have major irreversible consequences. Some basic organization theories, particularly Leavitt's organizational model, describe organization as five dimensions: goals, people, techniques, structure, and environment. Changes in one dimension require adjustment in others to insure optimization of the organization [Ref. 9: p. 389].

Another theory is that the organization has three dimensions which are technical, political, and cultural. Strategic change involves consideration of all three of these organizational dimensions [Ref. 10].

The objective of this experiment is primarily improvement of the effectiveness of the multi-crew manning system, and secondly, a guide for the Navy's strategic planned changes from a traditional single crew manned Navy to a modified multi-crew manning system. The Navy has two conflicting goals which are preparedness and additional patrol missions which cause personnel dissatisfaction about their jobs and a high turnover rate of the crew members. That phenomena could be interpreted to show that the navy's structure is inefficiently organized and should be reconsidered. The Navy designs their vessels to fit both mission requirements, but it is difficult to satisfy two conflicting missions. The primary mission requirements are heavy armament rather than high speed. The secondary mission requires high speed rather than heavy armament. This compromise results in high construction cost and reduced armament. Also, the Navy's small patrol boats are concerned mainly with the additional mission, which requires quick reaction time with limited endurance. But, after a short high speed chase, the boats drop speed rapidly.

The organizational structure of the Navy causes difficulty, too. This is the differentiation and integration problem. For the primary mission, the Navy forces should keep concentration of their forces, but to perform the secondary mission, forces should be distributed to each area with supporting facilities. To distribute the supporting facilities calls for enormous costs.

Therefore, sometimes the forces are deployed temporarily. The people dimension has two central issues: leadership and motivation. In order to achieve improved organizational performance and to be able to strategically change an organization, people must be motivated. Motivation is the willingness of an individual to invest energy in specific activities. Thus, getting workers to produce a certain numbers and quality of output per day is largely a motivational problem [Ref. 10: p. 86].

The Navy members regard this secondary mission as meaningless action since the members do not feel any kind of achievement from the additional actions. Every year, the Navy may succeed only a few times in the anti-infiltration operations. But, compared to the numbers of forces which are engaged in that action, the operation's productivity is very low.

Therefore, even though the additional mission has enormous importance and the rewards for the successful crew members are great, still the crews are not motivated.

A. OBJECTIVE OF EXPERIMENT

This experiment will concern structural and technical dimensions of the Navy. Moreover, this technical adjustment will be loosely coupled with another dimensional cycle. Primarily, the modified manning system will affect the Navy's cultural dimension, and finally it may affect the political dimension too. The basic assumption of the Navy is that the traditional single crew manning concept is dominant in the Navy, therefore people are worried about absenteeism which may be a result of implementation of a multi-crew manning system. As the interview results of the Coast Guard and the U.S. Navy reveal, higher ranking service members prefer a single crew rather than a multi-crew manning system since they believe a single crew manning system is more conducive to maintenance of crew morale and team spirit. I believe this could be categorized as resistance to change and part of the cost of improvement of the organizational effectiveness. Also, the environmental and organizational factors of the two maritime services, US and Korean, are very different from each other. But, the Coast Guard study result reveals increased effectiveness. The Korean Navy may succeed in implementing this modification.

In any case, it is my opinion that the existing manning system doesn't optimally accomplish the two conflicting goals. Therefore, the objectives of this experiment are: First, figure out the cost of the change in the Korean Navy, and find out the best method. Secondly, regard this experiment as a step toward advancement and preparation for the future of the Navy.

The first objective could be viewed as C = [ABD] > X which David Gleicher has developed as a simple formula for determining whether change will occur.
C = change, A = level of dissatisfactionwith the status quo, B = clear desired state, D = practical first steps toward the desired state, and X = cost of change [Ref. 11: p. 25].

This experiment can be regarded as a practical first step toward the Navy's desired state which is accomplishment of the two conflicting goals in an effective way.

Organizational design is a technology that offers a wide range of possibilities, and organizational change is an ongoing dilemma.

"Because organizations are perpetually in flux, undergoing shifts and changes, none of the three problems is ever solved. At different points in time, any one of them, or some combination, may be in need of adjustment. Adjustments in each of three problem areas can be conceptualized in cyclical terms. These cyclical manifestations overlap and interact with each other." [Ref. 10: p. 11].

If this experiment result is successful, then why not adopt the result. If it is not successful, then what are the problems associated with the experiment, and how can we remove the reluctance for the Navy's future improvement?

B. RESOURCE REQUIREMENTS / ESTIMATED COST

The experiment will be designed for a comparison of the current existing organization with other alternatives. The primary resources of the anti-infiltration forces are the patrol boats and crews (Table 3). The patrol boats configurations are :

- Operating and maintenance costs are annual averages of the total forces.
- Operating costs include fuel, payment, ammunition, food, and other miscellaneous.
- Maintenance costs include material resources, except laborcosts.

The additional resources requirements are different depending on the proposed alternatives. The proposed alternatives are designed to follow the other navies currently implemented manning systems. Each alternative has been designed with consideration of their specific mission requirements.

TABLE 3
PATROL BOATS CONFIGURATION

SHIP TYPE	Patrol Killer(PK)	Patrol Killer-M(PKM)
CREW NUMBER	24-3 Officers-	28-4 Officers-
DISPLACEMENT	80 full load	170 full load
DIMENSION	84.3x17.7x6.6	121.4x21.6x8.2
FUEL CONSUMPTION	crusing-96gl hour max-sp-240gl hour	120gl hour 300gl hour
OPERATING COST	$47,000	$71,000
MAINTENANCE COST	$20,000	$33,000
CONSTRUCTION COST	$2 million	$4 million

ALTERNATIVE A: Two crews per ship

ALTERNATIVE B: Three crews for two ships

ALTERNATIVE C: One extended crew per ship

ALTERNATIVE D: One maintenance team per squadron

Additional resources requirements of Alternatives A, B, C, and D are:

Alternative A: One entire crew per ship

Retention cost of crew

Retirement Pension Fund for career personnel

Food services

Facilities for human resources

-Housing

-Training & Education

Alternative B: One entire crew for two ships

Retention cost of crews

Retirement pension fund for career personnel

Food services

Facilities for human resources

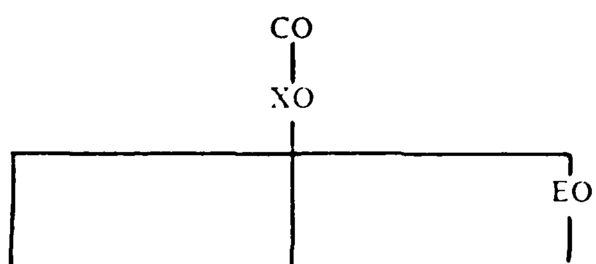
-Housing

-Training & Education

Alternative C: Additional human resources are 9 personnel each, who could augment the existing crew, providing two complementary limited duty crews.

Obviously, navy vessels table of organization should be considered adequate only to support the temporary pre-hostility capability. Therefore, the total human resources requirement might exceed the basic essential number of operators. My concern is that the anti-infiltration operation doesn't require the same level of staffing as would be required to support the primary mission. Therefore, I derived the number of additional crew consisting of two separate crews. The two types of boats have the following organization tables:

TABLE 4
PATROL KILLER



Weapon Department (9 Personnel)	Operations Department (6 Personnel)	Engine Department (6 Personnel)
5 Deck	1 Quarter	4 Engine
4 Gunnery	2 R D	1 Damage Control
	2 Comm	1 Electric
	1 Medical	

Additional human resources requirement

2 Gunnery	1 Quarter	1 Engine
1 Deck	1 Rader	1 Damage Control
	1 Medical	1 Electric

TABLE 5
PATROL KILLER-M

CO

XO

OP | EO

Weapon Department (11 Personnel)	Operations Department (6 Personnel)	Engine Department (7 Personnel)
6 Deck	1 Quarter	5 Engine
4 Gunnery	2 Rader	1 Damage Control
1 Fire Control	2 Comm	1 Electric

Additional human resources requirement

2 Gunnery	1 Quarter	1 Engine
1 Fire Control	1 Rader	1 Damage Control
	1 Medical	1 Electric

In the PK, the XO is in charge of weapons and operating departments, and the EO is charged strictly with the Engine Department. In PKM, the XO is in charge of the Weapons departments; the head of the Engine Department could be assigned to the Engineering Officer and the Chief Engineering Petty Officer.

Another consideration is that the Korean Navy has identified Navigators and Engineering Officers as line officers. The navigator is a line officer and eligible for promotion to operating departments, Weapons Officer, XO and even CO. The Engineering Officer is a specialist, strictly concerned with the Engine Department. The Navy has recently decided to alternate these specialities from conventional discrimination to cross functional utilization. According to the new personnel policy, the navy will not identify Navigators and Engineering Officers. Because of this, one separable crew has more realistic possibilities.

Alternative D requires additional human resources for ship maintenance. This alternative is proposed to make the crew free from advanced maintenance, since the advanced maintenance facilities are located far from the ships' normal deployment places. Some crew members regard this advanced shipyard maintenance period as time underway. Because of the geographic distance between their family location and the maintenance facilities, the crew must be separated from their families. Another reason is that the crews are engaged for maintenance during the in port period after three month of action, which presents difficulties for relaxation and sea readiness. By separating operation from maintenance the crew could utilize their in port time for crew maintenance, like training and other varieties of work, which would enhance concentration on their primary duties. To enhance this, the maintenance team should be qualified to take responsibilities for their performance. More precisely, the team will have to be composed of technically oriented personnel.

As I stated earlier, the Navy plans for junior engineering officers to have opportunities as navigators. If lieutenant grade engineering officers are assigned as commanding officer in charge of sailing from the separate squadrons to the maintenance facilities, then they could gain experience in line jobs as well as in operational areas. Since the activities of ships during this ferrying operation would be limited, assignment of less than fully qualified commanding officers should not cause difficulties.

I have been looking at apparent cost. But, to analyze the cost of future implementation, all of the relevant costs have to be carefully considered: such as, what is the training and educational cost for the increased members of the crew. And, as the Navy implements the modified manning system, naval vessels' steaming hours will increase, and it is anticipated that the total life cycle cost will increase [Ref. 12: pp. 19,28].

Life cycle cost includes (1) Research and Development costs, (2) Production and Construction Costs, (3) Operation and Maintenance Costs, and (4) Systems Retirement and Phase-out Costs. In this thesis, among the four kinds of costs, Operation and Maintenance Costs must be regarded as the cost of sustaining operations, personnel, and maintenance support. Since, during the wear-out period, the failure rate of the vessel increases rapidly, the wear-out period will come sooner than on a single crew vessel.

Additionally, in the long run, increasing human resources will cause increase of pension payment for career personnel. The Navy should plan for utilization of senior crew members. The Navy should alter the current table of organization for these senior personnel to provide facilities, housing, etc. This is dependent on a decision concerning the adequate level of personnel in the Navy.

The current situation in the Navy indicates little concern for the opportunity cost of non-career personnel. Since every Korean male adult has an obligation of national defense, payment of non-career personnel is low, and the overall direct cost for these personnel is minor compared to other human maintenance costs.

C. EXPERIMENTAL DESIGN

My biggest concern in experimental design is, first, how to measure differences between the conventional manning system and the modified manning system. Secondly, how can we remove the negative side of anticipated consequences which is revealed in the experience of other navies? Thirdly, how can we manage this manning system more effectively?

The experiment has three phases: beginning, implementing, and evaluation. In the beginning stage, unfreezing the current situation is the primary task. During the implementation stage, transition will occur. Finally, review the experiment and evaluate the results, which can be viewed as rephasing and beginning again (Table 6).

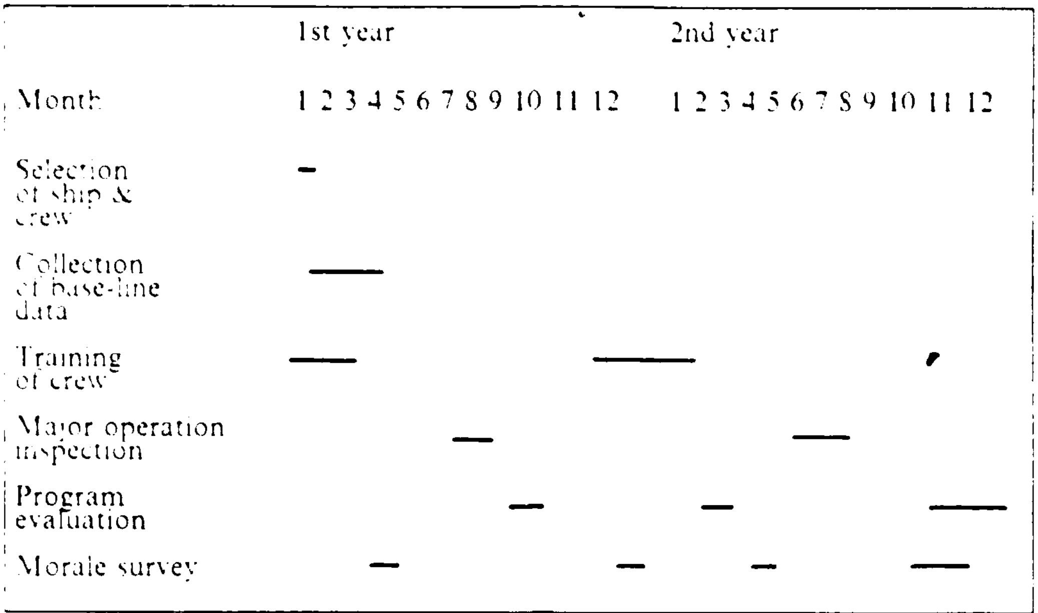
a. Begining Stage

The primary issue of this stage is that during the overall planning, participants should be oriented and become involved in the planning. This will make the experimental planning more explicit. To set the time table of the implementation, I propose a two year plan, with two one year phases, since officer assignments are generally for a one year term. During the winter time, most of the navy's light forces are engaged in maintenance activites at maintenance facilities. The reason is that during the winter, Korean territorial waters are unfit for small boat operations, and North Korean special forces have difficulty conducting infiltration activities. As spring arrives, infiltration activities increase and anti-infiltration activities increase apace. This continues until winter arrives again. So, during January and February, the navy has to finish the beginning stage and move on to the implementation stage.

The participating boats should be deployed separately, since if the participants involved in the experiment are close enough to investigate each others

TABLE 6

PLAN OF ACTION AND MILESTONES



performance, the experiment results may not show significant differences between the manning systems. Fortunately, the navy keeps independent squadrons at each island along the Korean territorial waters, which will enhance the separation of this experiment.

Also, the Navy should plan for operation of the participating vessels and utilization of rest crews in port. Operations are concentrated at night time. The problem associated with these night actions is that after coming back to port, the crew sleeps until 10 AM and begins work. But, during the morning time, after 10 AM, they are still tired because of the previous night's activities. Most of the crew skips breakfast. Some of the crew must work for some period immediately after return to port, for refueling and preparation of necessary reports, or emergency trouble shooting activities. After lunch, the crew becomes active in preparation for the next night's activities, and to maintain their platforms. But, during the day time, they are sometimes involved in other activities, training, ship level education, administrative activities, and other sea actions. Therefore, defining the multi-crew operation concept is another central issue. The possible operation concepts are:

(a) Separating the rest crew from the ship's activities. Rest crews should be engaged in human maintenance activities, training, advanced education, and rest. I propose that four weeks continuous duty assignment is appropriate.

(b) Rotate the crew between day and night duties. The Gold crew will be assigned to day duties which include maintenance and administration. After sunset, at the end of the normal duty day, the Blue crew will take over the ship and conduct sea duty. Overall, this suggestion could be facilitated at one common chain of command, otherwise is may lead toward inefficiency since the Gold crew's basic assignment is supporting the Blue crew's performance. The rotation period under this proposal would be six weeks.

Evaluation of the current stage could be viewed as the yardstick in the evaluation of the experimental results. We should keep in mind this evaluation and keep track of the experimental results. The evaluation could be categorized as two central issues: one is productivity of the crew, and the other is improvement of crew morale. These two could be viewed as quantitative and qualitative aspects of the benefits.

Education for the Experiment : We should be aware that this kind of modified manning system has not been previously attempted in the Navy. So, the purpose of the education is first to let the participants have an overview of the experiment and during this period, participants' questions are regarded as another diagnosis of the current stage. Also, feedback of these questions will involve the crew in the experiment. The navy has to keep in mind other navies' experience, and their reluctance to implement, which will give the crew opportunity for psychological readiness and learning. The Navy could learn from these demands for education about crew member desires to be engaged in rest time and human resources.

b. Implementation Stage

In March, this experiment will start in each squadron. During this stage, the senior officers interruption of the experiment can be anticipated which derives from their own perceptions. In many other cases in the management world, many managers are confound about the behavior of their subordinates because they rely on their own perceptions of the situation and ignore what their subordinates feel. This may occur and mislead the experiment. Therefore, once the experimental plan has been established, implementation should be directed by higher level officers with strong support of all intermediate officers.

c. *Evaluation Stage*

The final stage of the experiment is evaluation and plan for the future. This final evaluation is discussed later (Data Required). As stated earlier, the plan for the future should be regarded as a stepping stone for future naval organization development activity. Therefore, even if the evaluation of the experiment indicates that this form of multi-crewing is inappropriate, further experimental design will be proposed by the participants and their superiors, resulting in improvements in naval organizational effectiveness.

D. DATA REQUIRED

Data required for the experiment are in two categories. One is searching for supporting evidence to prove productivity of the experiment, which could be viewed as quantitative data. The other one is to support evidence for improvement of quality of crew performance, which are the results of the crew morale improvement.

The quantitative data are: operating costs, maintenance costs (direct and overhead), steaming hours, maintenance hours, training and education hours, and time available for other assignments. Operating costs and steaming hours will drive operating costs per hour which could be compared with the conventional manning system. The maintenance costs and maintenance hours will drive members' productivity on their maintenance work. The central meaning of this data could be interpreted as contradictory evidence to critical opinions that multi-crewing will increase absenteeism.

Training and education hours of the participants can be compared directly with conventionally manned ships, and will reveal any benefits of this manning system. Proper cross functional utilization of the rest crew will be critical to the success of this experiment.

There will be increases in some costs, particularly direct costs. Other costs will be constant, such as certain overhead requirements. It is unlikely that any costs will decrease. Proper evaluation requires consideration of level of performance so that the cost per steaming hour should be primary.

The primary source of qualitative data is inspection results of crew performance. The navy conducts various kinds of inspections, such as maintenance, gunnery, training, administrative, and crew indoctrination. Crew indoctrination inspections are evaluations of crew morale and are referred to as Spiritual Inspections. Administrative and crew indoctrination inspections are similar to the US Navy's Inspector General.

In this evaluation of crew morale, we should analyze the results in two aspects: One is improvement in the quality of work life and the other is how much the crew is motivated by accomplishment of the experiment, which could be interpreted as expectancy outcome theory.

Elements of productivity are capital investment, innovation, learning (skill and competence), and motivation and commitment. The first three sources of productivity are in an organizational environment which enhances motivation and commitment. People productivity requires four major conditions: motivation, knowledge, actual capacity, and integration. The more critical issue concerns human resouce development over time, whether that involves training, career planning, reward systems, or organization redesign [Ref. 13: p. 37].

Therefore, we should carefully look at how much opportunity and power, plus a structure for distributing these qualities throughout the work place, provides the link between productivity and quality of work life. Also, a person's motivation to exert effort toward a specific level of performance is based on his or her perception of associations between actions and outcomes. Motivation (M) is expressed as follows:

$M = \{E \rightarrow P\} \times E [\{P \rightarrow O\} \{V\}]$

The liklihood that a desired performance will lead to various outcomes, is referred to as the P (performance) to O (outcome) expectancy. Each outcome is given a value, either positive or negative. The strength of a person's motivation to perform effectively is influenced by (1) the person's belief that Effort (E) can be converted to Performance (P), and (2) the net attractiveness of the events that are perceived to stem from good performance [Ref. 14: p. 71]. Therefore, if participants in the experiment believe their efforts are to become successful, then that will improve their quality of work and its expectation will motivate them.

E. EXPECTED RESULTS / LESSONS TO BE LEARNED

The expected results will be both of benefits and cost of the experiment. The major four benefits are: 1) Quantitative data to explain effectiveness of multi-crewing; 2) Lessons learned regarding management of multi-crewing; 3) Increased motivation, decreased resistance to multi-crewing; 4) Experienced officers and crew to help future implementation of multi-crewing.

The quantitative results will be increased productivity of the available resources engagement. More precisely, reduced cost per steaming hour, as USCG experience

shows a 44% of increase in productivity (steaming hours) with little increase in operating cost and maintenance. The anticipated results of the experiment will be less advantageous than experienced by the USCG. The reasons are differences of the environmental factors: weather, and current action engagement days. The Korean territorial waters have more inappropriate time for small ship's operation. Korea has a longer winter time than most of the U.S., with strong wind and high waves, Summer time sea conditions are often rough, too. Currently, patrol boats are engaged in both primary and secondary missions as long as the weather allows. Therefore, this experiment might reveal little significant improvement in productive days, but hours of the productive action will show improvement.

Even though, the quantities of the productive action will not be much improved, the quality of the actions will be much improved. The crews will not perform their at sea jobs like just waiting time to go to ports. Another outcome is increased time of training and education of the crews for the primary mission, including cross functional areas. Therefore, even officers could easily change their assignments from one area to another, which will require fully different knowledges and different levels of skill. For example, operating officers could take engineering officers educational courses during in port time in anticipation of future assignments.

The crew motivation will show significant improvement, since the crew could take advantage of increased opportunities for self-development and time for cross training into fields which offer greater opportunities for promotion. These factors will affect the crew, and the results will reduce the resistance to multi-crewing greatly.

Other dimensional benefits are the potential benefits for the Navy in the future. Those factors are hard to identify as numerical datas in the short run, but certainly it will give considerable impact to the Navy, in the long run.

Negative outcomes of the experiment may be: 1) multi-crewing may not be appropriate in a certain situation, 2) there may be cost overruns, 3) retention may suffer, or 4) overhead costs may increase.

Multi-crewing may be inappropriate when the patrol boats are taking action mainly for the primary mission. Those boats are then deployed near the Demilitarized Zone and maintain high readiness for interdiction of the Northern Korean Navy vessels invasion. Those patrol boats rarely see real action while the crews are deployed far from their families and other facilities. Although, productivity may not increase, the crew could get benefits from the additional crew's existence. They could reduce the time of being far away from civilized society, and this could be regarded as one benefit.

In those cases in which the primary mission has more priority than the secondary mission, the experimental design willl not be appropriate, since the additional cost will be higher than the benefits. Also, in the long run, retention cost of the excess crew members will increase and the current situation doesn't allow for implementation of multi-crewing because of shortage of human resources. Therefore, personnel assignments and scheduling of ships will become difficult. North Korea has more Naval vessels than the South. In order to support national defense, more vessels are required, and are being built by the Navy. These shortage of human resources are accumulating, as increasingly more new ships are activated.

V. CONCLUSION

In this thesis, I have analyzed benefits and costs associated with other Navies experiences in their modified manning systems, and suggested possible ways of implementation in the Korean Navy. The purposes of this chapter are to explore what will be the future potential benefits from implementing multi-crewing, recommendations for future activities, and required further research.

A. POTENTIAL BENEFIT OF MULTI-CREWINGTO ROKN

Basically, the potential benefit to the Navy are lessons to be learned during this experiment. The Navy has long been concerned with improving organizational effectiveness. But, those come from management conjectures, not from specific experiments.

Partly, those judgements are derived from the Navy's experiences through its history, and those judgments might not be appropriate for the current situation which is constantly changing. Therefore, we should regard this experiment as a learning opportunity of organizational processes. The experimental process may raise unexpected questions which cannot be satisfied.

Lessons learned regarding management of multi-crewing are effective ways of training, leadership, personnel management, and scheduling of logistics. Methodology to measure motivation and analysis will be improved, too. Additionally, the Navy should keep in mind future human resources requirements, especially highly skilled personnel in specialized functional areas which can not be acquired in a short period of time. So, in the event of war, the additional crew members could be easily transferred to newly constructed ships without any unnecessary consumption of training time.

B. RECOMMENDED EXPERIMENT

Expected outcomes of the four proposed alternatives will differ by operating concepts and depend on which purpose the navy will give more priority. The navy could emphasize either productivity or human resources considerations.

```
ALTERNATIVE A:  Two crews per ship
ALTERNATIVE B:  Three crews for two ships
ALTERNATIVE C:  One extended crew per ship
ALTERNATIVE D:  One maintenance team per squadron
```

(1) Separating the rest crew from the ship's activities. Rest crews should be engaged in human maintenance activities, training, advanced education, and rest. I propose that four weeks continuous duty assignment is appropriate.

(2) Rotate the crew between day and night duties. The Gold crew will be assigned to day duties which include maintenance and administration. After sunset, at the end of the normal duty day, the Blue crew will take over the ship and conduct sea duty. Overall, this suggestion could be facilitated at one common chain of command, otherwise is may lead toward inefficiency since the Gold crew's basic assignment is supporting the Blue crew's performance. The rotation period under this proposal would be six weeks.

The appropriate combinations of each alternative and possible operational concepts are: Alternatives A and B could utilize (1) above (distinctly separate crews), since these two alternatives have single crews, members of which would be assigned on a rotating basis to meet the current table of organization. These crews currently accomplish their missions without external assistance. The existance of additional crew members would give them opportunity for other primary mission requirements.

Alternative D could adopt suggestion (1) above with minor adjustment of the time period. Actually, this crew could have three weeks of free time away from the vessel after three months of operations. Therefore, the crew could get partial benefit from the multi-crew manning system which could be motivational incentive to the crew.

Alternative C is proper for implementation of suggestion (2) (an augmented crew allowing for rotating assignments) above since this alternative is designed to be heavily concerned with productivity with a small increase of crew members which could be engaged in anti-infiltration operations, although they may not be adequately staffed for their primary mission. This alternative has one common commanding officer who could take advantage of this manning system for accomplishment of his mission with greatly reduced difficulty.

The hypothesized desires are 20% increase of the rotating manned crew's operational readiness ship day at sea.
The expected desired results are shown in Table 7.

TABLE 7

EXPECTED RESULTS

Alternative	A	B	C	D
Operational readiness ship days at sea	1.3X	1.2X	1.4X	1X
Economic cost Operating cost	1.2X	1.15X	1.25X	1.1X
Maintenance cost	1.25X	1.2X	1.3X	1X
Additional manpower requirement	2X	1.5X	1.3X	1.25X
Human resource considerations:				
Morale	Medium	Medium	High	Low
Retention	High	Medium	Medium	Low
Quality of life	High	Medium	Medium	Low

Comparison between Alternative A, B and C is that Alternative C would most greatly increase operational readiness days at sea, since the crew changes every day, and each crew could perform anti-infiltration operations, while in Alternative A and B, rest crews are fully separated from the ship and engaged other activities. Therefore, Alternative A and B limit operation to only one crew and one ship, while Alternative C could operate one ship with two teams. Comparing productivity of each alternatives with ship days at sea may not be appropriate. Operational hours might be more accurate than days, and the anticipated result of Alternative C is 40% increased operational readiness at sea, which will be similar to 82 foot USCG cutters. The increase in operational readiness days for the other alternatives are derived from the study of the USCG. Operating and maintenance cost will increase depending on operational hours of the ship. The Navy's biggest item of operating cost is fuel consumption. Propulsion equipment and electric generator maintenance cost will increase linearly according to operating hours. Therefore, Alternative C will increase maintenance costs more than the other alternatives.

Human resource considerations are determined according to each manning system's working conditions. Alternative D will provide similar crew working condition to the current situation, except for level three maintenance. The crew would be separated from ship maintenance and engaged other activities. During operational

periods, the crew should put most of their time in maintaining high readiness. Alternative C is better than Alternative D, but worse than A and B. Even the lowest level of improvement in the human factor is better than the current state.

Therefore, Alternative C might be the best model for the Korean Navy, since the one extended crew per ship could show significant improvement of steaming hours with little increased resources. Additionally, this alternative has one advantage which is that the manning system has one common commanding officer. Even though the crews conduct their duties separately, they would maintain interdependence and commonality between teams on a daily basis, and during maintenance periods, both teams will perform their jobs cooperatively. The Commanding Officer of this manning system will have less difficulty than those with two separate crews per ship and a rotating manning system. For the Navy unexperienced with multi-crewing, it will lead the experiment to desired results.

C. FUTURE RESEARCH

Areas for advanced research are: 1) sensitivity analysis of additional members of the manning system; 2) planning for rest crew utilization; and, 3) development of effective support logistics.

I have recommended an increase of nine additional members to organize two *separately operating 16 man* teams. Would one additional member enhance ship operation, or would one additional member be revealed as excess?

The purposes of this experimental design are not only maximization of resources productivity, but also, increasing crew qualification and level of knowledge for the primary mission of the Navy. This would increase militery readiness, and would be an additional benefit of multi-crewing. Currently, most crew time is spent on the ship underway, or preparation for sea, and the crew has limited opportunities for training and advanced education. The small number of crew members in any specialization limits effective on the job training. Crew members assigned to formal education courses are absent from regular duties and the remaining crew members must perform additional duties to cover the trainee's assignments.

To maximize this modified manning system requires more facilities and other supporting human resources. The relatively small Navy could improve their organizational effectiveness through structual adjustment, more easily than could a larger navy.

LIST OF REFERENCES

1. *Jane's Fighting Ships*, 1986.

2. Burke W. w., *Organizational Development Principle and Practices*, Little, Brown and Company, Boston, 1982.

3. Interview between G. Nies, USN, Lieutenant, USS Snook SSN-592 Division Officer, Engineering Department, Monterey, CA., and the auther, 10 October 1986.

4. Interview between C. Thompson, Lietenant Commander,USN, USS George Washington SSBN 656 EO XO, Monterey, CA., and the auther, 9 October 1986.

5. Eccles R. C., *Multi-Crewing Ships: How and Why*, M.S. Thesis, Naval Postgraduate School, Monterey, CA., December 1986.

6. Sudgen, Williams, *Principles of Practical Cost-Benefit Analysis Shadow Pricing*, 1973.

7. Nigro, Lloyd G., *Decision Making in the Public Sector*, 1984.

8. Sassone, Peter G. and Schaffer, William A., *Cost-Benefit Analysis (A handbook)*, 1978.

9. Stoner, James A. F., *Management*, Second edition, Prentice-Hall. Inc, 1982.

10. Tichy, N. M., *Managing Strategic Change*, Wley-Interscience, 1983.

11. Beckhard, R. and Harris, R. T., *Organizational Transitions: Managing Complex Change*. Addison-Wesley Publishing Co, 1977.

12. Blanchard, B. S., *Logistics Engineering and Management, 3rd edition*, Prentice-Hall, Inc. 1974.

13. Stein, B. A., *Quality of Work Life*, AMA, 1983.

14. Nadler, D. A. and Lawler, E. E., *Motivation: A Diagonistic Approach*, AMA, 1983.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943-5002	2
3.	Professor Carson K. Eoyang, Code 54Eg Department of Adiministrative Science Naval Postgraduate School Monterey, California 93943-5000	1
4.	Capt. E. V. Haag , Code 54HV Department of Adiministrative Science Naval Postgraduate School Monterey, California 93943-5000	1
6.	ADCNO for Education & Training Division P.O.Box 201-17 Youngdeongpo Gu, Singil 7 Dong Seoul, Korea	1
7.	Library Postal Code 602 Jin-Hae Si, Naval Academy Seoul, Korea	1
8.	Lt Kim, In San Postal Code 300 Chung Nam, Dae Jeon Si, Jung-Gu, Ka Yang Dong 440-53 Seoul, Korea	10

END

4-87

DTIC